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REPORT NO. 310/5

METALLURGICAL EXAMINATION OF METAL

Submitted by Wm. D. Breazeale

Through the Ordnance Office - O.O. 400.111/5702

By

M. B. Gruzdis
Jr. Chemist

H. G. Carter
Assoc. Metallurgist

April 4, 1936

WATERTOWN ARSENAL
WATERTOWN, MASS.

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O.O.400.111/5712 Breazeale, Wm. D.
W.A.400.111/60 1st Ind.

Watertown Arsenal, Watertown, Mass., March 25, 1938.
To: Chief of Ordnance, U.S.A., Munitions Bldg., Washington, D.C.

1. The sample steel submitted had the following composition:

C	Mn	Si	Cu	Al
.80	.25	.205	.09	Trace

2. The corrosion resistance was not measurably superior to that of an annealed plain carbon eutectoid steel with which it was compared.

3. Physical Test

Yield Point	T. S.	El.	Red. of Area	Break	Appearance of Fracture
63,000	101,900	20.0	40.0	Middle third	Irregular, coarse structure, segregated, checks on stem.

Rockwell "C" Hardness - 23-24

4. Microscopic examination showed a steel slightly below eutectoid composition in the annealed condition. It was relatively dirty and large grained.

5. This arsenal could find nothing unusual or new in the composition or any indication that the copper addition had contributed any special property to the steel. In fact, the amount of copper found might be expected as a residual in almost any steel procured.

For the Commanding Officer:

James L. Guion,
Major, Ordnance Dept.,
Director of Laboratories.

Incls. n/c

Report No. 310/5
Watertown Arsenal

April 4, 1938

Metallurgical Examination of Metal

Submitted by Wm. D. Breazeale

Through the Ordnance Office - O.O. 400.111/5702

Object

To observe the corrosion resistance of Wm. D. Breazeale metal. Ex. Order 56-A21.

Material

Specimen 1" x 3/16" x 1/8" was used for tests. Partial analysis: .80% C; .25% Mn; .205% Si; 0.09% Cu; Spectrographic analysis: Mn present; Al (trace); Si present; Mo, V, Cr, Ni nil. For comparison, measurements were made on a plain carbon eutectoid steel in the annealed condition.

Conclusion

The corrosion resistance of Wm. D. Breazeale metal is not measurably superior to that of an annealed, plain-carbon eutectoid steel.

Method

The method used was essentially that described by Benedicks and Sundberg in the Journal of the Iron and

Steel Institute, 1926 (p. 177). The electrode potential behavior in normal ferrous sulphate solution both in an atmosphere of hydrogen and in an atmosphere of oxygen was measured for each specimen. Measurements were made against a normal calomel electrode. The specimens were finished with #00 emery cloth and sealed in glass tubing by means of black wax.

Results

In an atmosphere of hydrogen, the initial potential of Breazeale metal against a normal calomel electrode was -.713, and after 24 hours decreased to -.718. With eutectoid steel the initial value was -0.709, and after 24 hours -.712. These values agree with those of Breazeale metal within the experimental error.

When measurements were made in an atmosphere of oxygen, the initial value for both Breazeale metal and plain-carbon eutectoid steel was -0.591. At the end of 22 hours the potential of the Breazeale metal had decreased to -0.610 and that of the plain-carbon steel to -0.612. Again these values agree within the experimental error.

Respectfully submitted,

M. B. Gruzdis

M. B. Gruzdis,
Jr. Chemist.

Metallurgical Examination of Metal

Submitted by Wm. D. Breazeale

Through the Ordnance Office - O.O. 400.111/5702

A sample of the above steel was submitted for examination. It was claimed that copper could be added to the steel in all proportions and make it completely stainless.

Conclusion

1. The sample was dirtier than the usual run of commercial steels. This dirt appeared to be largely oxides but no attempt was made to identify it.

2. The steel etched readily with 1% alcoholic solution of nitric acid. It was therefore far from stainless.

3. No precipitated copper was observable up to X1000 magnification. But there was a micro segregation as the various grains etched at different rates.

4. The structure was pearlite and sorbite of slightly less than eutectoid composition.

5. The grain size was of two orders:

   (a) A remnant of the old austenitic grains whose grain size was -2 to 0, and

   (b) A general grain size of 3 to 4.

Chemical Analysis

C .80, Mn .25, Si .205, Cu .09

Discussion

The sample was very dirty (Fig. 1). The amount of dirt would indicate that the steel should be classed as rather poor quality commercial steel.

No difficulty was experienced in etching the steel with 1% alcoholic solution of nitric acid. As far as could be observed while etching, the attack was similar to that of an annealed carbon steel.

The structure (Figs. 2 and 3) resembled a hot-forged steel which was air cooled from a rather high temperature. There was considerable scattered micro segregation and the grain size was of two orders, (a) very large = -2 to 0, and (b) = 3 to 4. This indicates that there had been only a little hot forging, and after the forging an air cool. Rather long lines of ferrite partially outlined the group of large grains. Ferrite was also found in grain boundaries of the smaller grains.

As only .09% Cu was found on analysis, the claim that copper can be added in all proportions is not established, and that amount of copper is found in many commercial steels.

In the structural condition as submitted, it is not more stainless than ordinary commercial carbon steels and

its micro structure is unsuited to ordnance use. The steel would have to be heat treated to make it suitable for ordnance purposes. What effect heat treatment would have on its "stainlessness" is unknown.

Respectfully submitted,

H. G. Carter,
Assoc. Metallurgist.

Fig. 1 - X100 - Unetched. Showing the dirty condition.

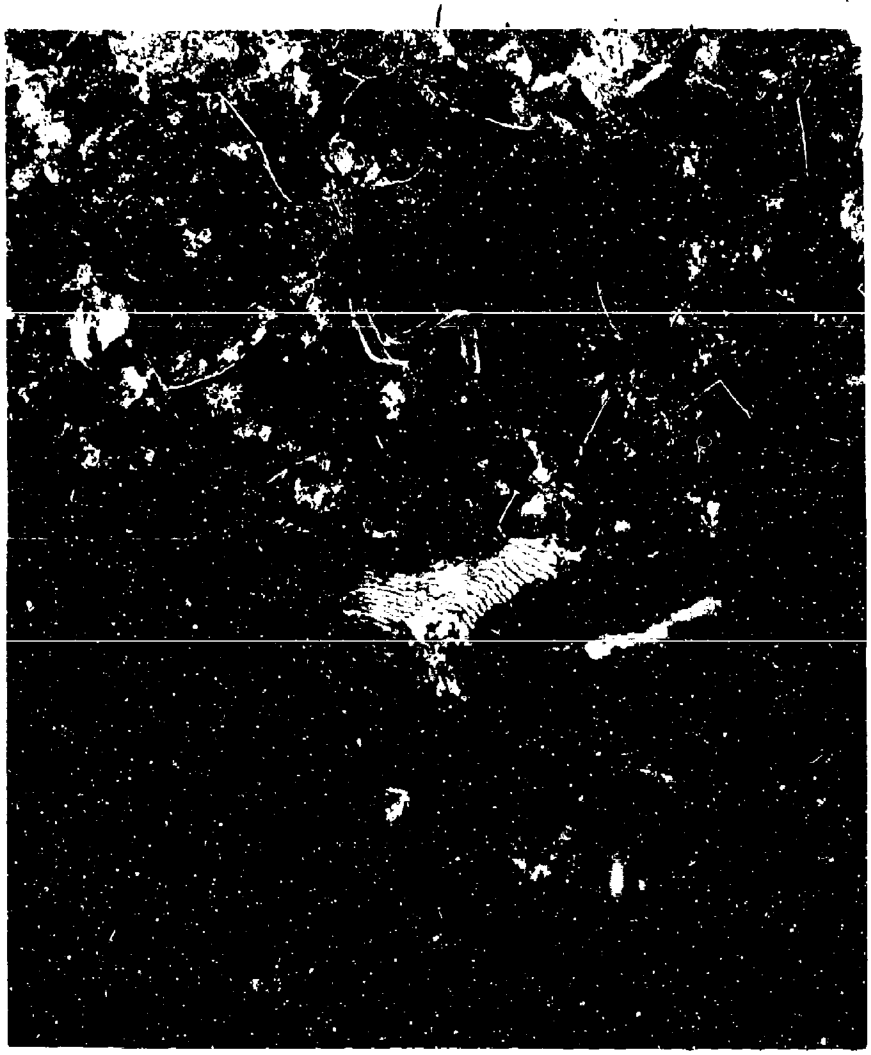
MM-422

Fig. 2 - X100 - 1% Nital etched. Ferrite partially outlining old and large austenitic grains whose size was -2 to 0 (A.S.T.M. Std.). The small grains have a size of 3 to 4.

MM-423

Fig. 3 - X1000 - 1% Nital etched. Sorbite and pearlite. Some ferrite along grain boundaries and crystallographic planes.

MM-424



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Report No. 320/1

February 25, 1938

Test of material submitted by O.O. 400.111/5702 -
Breazeale, Wm. D. Ex. O. 56-A21

Diam. In.	Yield Point	Tensile Strength	Elon.	Red. of Area	Break	Appearance of Fracture
.113	63,000	101,900	20.0	40.0	Middle third	Irregular coarse structure segregated, checks on stem.

Hardness

Rockwell "C" 23-24

H. C. Mann